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ABSTRACT -- KEY POINTS

BRDF/Albedo Product

Version 1 software was created and readied for delivery to SDST as the semiannual period reported here drew to a close. Highlights of these coding activities were the adaptation of the code to version 1 i/o HDF product formats, formulation and implementation of the ECS-, MODIS- and product-level metadata fields, and implementation of the version 1 level 3 grid referrencing scheme, including nested gridding. The code was made considerably more efficient, leading to substantial savings in projected computer resources required. The science of the algorithm was improved at the same time. Much of this work was carried out by a programmer newly hired in the period, Jim Tallent.

A comprehensive sensitivity and accuracy study was performed for BRDF and albedo retrieval. Expected product accuracies were determined as a function of latitude, time of the year, and land cover type for simulated MODIS and MISR combined angular sampling and shown to be a few percent at the sun zenith angle of observation. Furthermore, a BRDF/albedo validation plan was submitted.

A paper outlining all aspects of the MODIS BRDF/Albedo Product was submitted to the Journal of Geophysical Research. Four papers concerning aspects of BRDF/albedo generation from MODIS were given at the IGARSS '96 conference and printed in the proceedings.

Land Cover/Land Cover Change Product

Writing and modifying Version 1 MODIS software for the monthly compositing algorithm and quarterly classification algorithm was a major initiative as was development and delivery of our draft validation plan. Algorithm development for the land cover and land cover change products continued with the pre-processing and analysis of multitemporal TM for Glacier National Park. Testing and modification of the neural net and decision tree classifiers continued on the 1-degree global NDVI dataset.

TASK PROGRESS

BRDF/Albedo Product

BRDF/Albedo Product Version 1 Software Delivery

There were no late problems with the beta-3 software delivered to SDST in the fall of 1995. In preparation for the version 1 software delivery due in the summer of 1996 a meeting was held in February between SDST and MODLAND. The team hired Jim Tallent as a programmer.

The version 1 BRDF/albedo software was very close to delivery to SDST at the end of the report period. All input and output formats were adapted to reflect version 1 changes. ECS-, MODIS- and product-specific metadata is also read and written in version 1 code; the product-level metadata was newly developed. A considerable programming effort went into making the code more efficient. This effort met with substantial success. Final timings are still outstanding, but indications are that a speed increase of as much as 75 percent has probably been achieved. All level 3 grid-internal referencing was changed to reflect version 1 conventions and the new nesting scheme. Science content of the code also evolved as advanced were made in the modelling effort. All code was run on the output generated by higher-order algorithms running before BRDF/albedo on SDST-provided synthetic MODIS data.

BRDF/Albedo Product Sensitivity and Accuracy Study

Sensitivity of the BRDF/Albedo Product to noisy inputs was studied as detailed in the last quarterly report. All studies were carried out using simulated viewing and illumination geometries for the MODIS and MISR sensors so that sampling effects could be studied. Results produced as a function of latitude, time of the year and land cover type led to the conclusion that the models slated for use in operational production are stable with respect to noise both for BRDF and albedo, not only at the solar zenith angle where observations were made but at other angles as well.

The influence of MODIS/MISR angular sampling characteristics on BRDF and albedo expected product accuracies was also studied. BRDFs for six different land cover types were investigated using Myneni's three-dimensional discrete ordinates code and the Ambrals model for inversion based on simulated MODIS/MISR sampling geometries. Both reflectances and black-sky and white-sky albedos were studied. The median expected product accuracies, when combined with the errors expected from the noise sensitivity study, were found to be of the order of 5 percent at the solar zenith angle of the observations, and 10 to 15 percent at other solar zenith angles.

BRDF/Albedo Product Validation

An extensive BRDF/Albedo validation plan was written as part of the MODLAND joint validation plan. BRDF model validation was distinguished from general pre- and post-launch product validation. The latter will entail continuous measurements at a suite of tower sites, to be established jointly with other MODIS product teams and other instrument teams, and a few selected aircraft campaigns over these sites to allow scaling. During the EOS test site meeting in late March a list of minimum and augmentation instruments was developed defining a tower site for radiometric validation.

BRDF/Albedo Product Science Advances

Besides the sensitivity and error study discussed above, spectral-to-broadband albedo converion was investigated with good success. The technique to be employed was shown to be accurate to within 1 percent in most cases.

Sampling theory as applied to the Ambrals BRDF model will allow quantitative quality assessment of the BRDF model parameters produced for the product.

The RPV BRDF model used by the MISR team was compared in performance with the MODIS Ambrals model and found to have no advantages. Generally, the two models performed very similarly.

Ambrals model inversions were carried out on AVHRR data for large scenes. One of these studies is based on colocated and cloud-cleared AVHRR data for the month of September over New England. Maps of model kernels show spatial coherence that may be related to land cover. Maps of albedo were produced from the BRDF inversions. A second study, carried out at University College London, inverted AVHRR data for a whole year over the HAPEX-Sahel study region, demonstrating the feasibility of the modelling approach being implemented for MODIS.

BRDF/Albedo Product Review

The product was presented to a review panel at the AM platform land workshop in May. Review reports are not in. Contacts to the MISR team (John Martonchik) and the POLDER team (Marc Leroy) are well established.

BRDF/Albedo Product Publications

A paper outlining the BRDF/Albedo Product and the Ambrals model validation was written and submitted to the Journal of Geophysical Research. Four papers with direct relationship to the BRDF/Albedo Product were given and published in the proceedings of the IGARSS '96 conference. These concern sampling influences on BRDF retrieval, albedo retrieval, and model validation.

Land Cover/Land Cover Change Product

During this reporting period, there was quite a bit of activity associated with development of the validation plan, including a Cal/Val meeting. Test sites for training and validation to support algorithm testing and product accuracy continue to be an important topic. We continued our work with advanced technology (AT) classifiers: neural nets, decision trees and adaptive classifiers including testing using the 1-degree AVHRR global dataset and a number of sites.

Validation Plan

A draft validation plan was developed and delivered in January 1996.

Test Sites

The lack of an adequate test site network and IMS is asignificant problem which greatly impedes algorithm testing and product validation for land cover (and other MODLAND products). These data are need for training, validation and accuracy assessment. We have begun developing a multi-level database for test site data.

Test Site Activities

Test site analyses continued in Arizona, Walnut Gulch and BOREAS. In the second quarter, ATSR data analysis in collaboration with J-P Mueller began as did TM-based algorithm testing with the Snow/Ice Team for Glacier National Park. Work continued on the testing and modification of the neural net and decision tree classifiers for use with the 1-degree global NDVI dataset. In Walnut Gulch, efforts continued on anlysis of AVHRR and TM data through the first quarter of 1996. Some preliminary work was performed on ATSR data from the BOREAS study site.

Algorithm Development

Feature selection work, begun during the last reporting period, continued. Research on neural net classifiers continues, especially their application to the global 1-degree NDVI land cover study. Pertinent issues include the use of limited training and validation (accuracy assessment) data, and geographical organization of the mutitemporal data ie. stratification into latitude or hemispheric regions.

Algorithm Coding

Toolkit integration was a substantial effort during the period. Toolkit deliveries included MAPI 1.4 (4/17/96), SDP Toolkit 5.1v1.01 (6/14/96) and Lbin 2c (6/27/96). The

MODLAND V1 metadata dictionary was developed and delivered (3/18/96). Coding for V1 deliveries continued.

ANTICIPATED ACTIVITIES DURING THE NEXT QUARTER

Efforts in the next quarter will be targeted primarily to the Version 1 software delivery. In addition, we expect our series of studies on the sensitivities and accuracies of parameter retrievels to be completed. Late in the quarter, we will attend the first international workshop on multiangular remote sensing in Beijing and present the latest results of our work to an international panel of distinguished BRDF researchers. In land cover, we will begin the development of a Central American land cover database as a prototype for the training and test sites to be used in land cover classification.

PROBLEMS/CORRECTIVE ACTIONS

During this reporting period, we did not encounter any significant problems requiring corrective actions beyond the everyday problems that occur in research and algorithm development.

PUBLICATIONS

An updated list of supported publications is shown below. Those marked with an askterisk (*) are being sent to MODIS under separate cover.

(List to be forwarded at a later time.)